Synthesis and characterization of azobenzene-based gold nanoparticles for photo-switching properties

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A series of new azobenzene based thiolated liquid crystals modified with gold nanoparticles were synthesized and characterized using a different mode of delegated tools e.g. FTIR, NMR and FESEM–EDX measurements for the structural properties of synthesized compounds. Polarized optical microscopy studies have revealed all the studied compounds having liquid crystalline properties, as a typical nematic phase. These liquid crystal capped gold nanoparticles' size was determined by TEM experiment. In addition, azobenzene-based gold nanoparticles containing flexible spacers showed photochromic behavior upon UV irradiation. These molecules exhibited strong photosmertisation behavior in solutions and their trans to cis isomerisation took about 44 s whereas the reverse process almost took place ranging from 82 to 125 min.

1. Introduction

Photoswitchable molecules attached to solid surfaces is of a substantial interest for the preparation of advanced nano-systems, leading to a variety of applications, such as information storage, molecular machines, and sensors [1–2]. A photoswitchable molecule can be converted from one form to another with light of one wavelength and can either revert thermally to the original state or can be reverted by irradiation with light of a different wavelength. In recent years, the photo-responsive molecules on metal nanoparticle surface has received significant attention due to the opportunity of using switching devices as photo-responsive components in optical storage, switching, photoswitchable surface wettability and molecular recognition applications [3–16]. Moreover, the hybrid or composite nanomaterials consisting of inorganic nanoparticle and photoactive organic molecules may provide light-controlled nano-devices [17–21]. For optical switching applications, one of the most used organic chromophores is mostly azobenzene or its derivatives. Generally, ‘azobenzene’ refers only to the parent molecule, though the term is now repeatedly used to refer to the entire class of substituted azo molecules. The unique commonality among the azobenzene molecules (azo’s) is the clean and efficient photochemical isomerization that can occur about theazo linkage when the chromophore absorbs a photon. Azobenzene, a photochromic T-type system, exhibits a reversible isomerisation process between its trans and cis isomers of different stability [22]. In addition, azobenzene containing compounds have two geometric isomers (Z/E) around the N N double bond; the trans isomer (E) is more stable than the cis isomer (Z). In this process, without any bond breaking, the photo reaction occurs due to the simple rearrangement of the electronic and nuclear structure of the molecule. The photo isomerism process (cis to trans) can be carried out either by heating or by irradiation with visible light [23]. The energetically more stable trans configuration will turn into the cis configuration when UV light of wavelength 365 nm shines on azobenzene systems and reversible to the original configuration is brought about either by keeping it in the dark (terms as called thermal back relaxation) or by illuminating with white light of higher wavelength (450 nm). According to the literature, gold nanoparticles derived using as biological molecules investigation such as DNA, protein have gained much interest in liquid crystal research as biosensor [24].

The present study focuses on the synthesis and photo-isomerization behavior of four new gold nanoparticles (Gold-NPs) decorated azo-based liquid crystals having azobenzene chromophores connected via a flexible–CH2–spacer. In this paper, substituted azo-derivatives capping thiol groups were employed for the preparation of decorated Gold-NPs and the photoisomerization performance of their solution phase have been investigated by UV–vis absorption spectroscopy. Interestingly, thermal back relaxation of the studied compounds were increased with respect to the flexible spacer size (–CH2–) increased. The morphology and photo-responsive properties of the gold nanoparticles modified azobenzene derivatives having different flexible spacers were characterized via FESEM and UV/vis spectroscopy. In this article, we report a preparation of the gold nanoparticles cover with a layer of